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CHAPTER TWENTY-THREE

ELECTRONIC DATA COLLECTION SURVEY

23-1.0 GENERAL

Electronic data collectors may be used to collect field survey information for highway improvement projects. There is a wide variety of hardware and software available to collect and interpret this information. However, it is not within the scope of this chapter to present procedures and guidelines that cover all situations as the Department accepts only MOSS format surveys.

Implementing electronic data collection does not alter the amount or type of survey information required for a highway improvement project. All the information that is required for a conventional survey is still necessary and is normally presented in a conventional survey book.

The correct location of topographical features is normally plotted by computer. Coordinates or station and offset values need not be presented on the plot unless the survey is submitted as a final product and the design is to be completed by others. However, all topographic features must be identified.

Property corner markers, easements, existing right-of-way, fences or other evidence of ownership, section and subdivision lines and corners and similar information which would ordinarily be shown within the limits of the survey must be plotted and identified with coordinates or station and offset values given on the plot.

All plotting should be conducted using the conventional line types and symbols as determined by the Department.

A “Road Plan” presents all major topographical features that affect the ground surface and that influences the interpolation or generation of contours and cross-sections. This includes such features as follows:

1. buildings,
2. roads,
3. top of banks,
4. toe of slopes,
5. ditch flow lines,
6. edge of water,
7. edges of streams,
8. lakes,

9. quarries,
10. walls, and
11. any other item that represents abrupt changes in slope or surface elevations.

All spot elevations should be depicted on the plot together with the elevation of each shot.

Section and other corner ties require a separate plot that includes all traverse and closure data together with the following:

1. error of uncertainty,
2. descriptions, and
3. evidence and references for all corners.

A bench circuit for elevation control should be given in conventional format and include descriptions and locations (i.e., station and offset) for all bench marks.

A conventional section plat and conventional notice of survey sheets are required. Please refer to Chapter Twenty-two for preliminary research requirements.

23-2.0 GUIDELINES AND PROCEDURES

The following sections present guidelines and procedures relevant to conducting electronic data collection surveys.

23-2.01 Field Book

An electronic data collection field book is a skeletal field book that contains supplemental data for the survey. Information pertaining to topography and the ground model information is contained in the data collector. The following presents information relevant to the electronic field book.

1. The field book format is standard letter-size paper.
2. Set-up the field book in the following sequence.
 - a. fly leaf page,
 - b. index page,
 - c. general information,
 - d. stream data (if applicable),
 - e. present structure tie-in (if applicable),
 - f. public utilities,

- g. alignment line “A,”
- h. bench tie-in circuit,
- I. bench level notes,
- j. level notes,
- k. level notes on present structure (if applicable),
- l. high water levels,
- m. testimony of local people (if applicable),
- n. section corner references,
- o. aerial cross references (if applicable),
- p. miscellaneous envelope (see Chapter Twenty-six for contents), and
- q. check guides (see Figure 23-2A, Guide for Checking Survey Book).

23-2.02 Alignment Baseline and Data

Information pertaining to establishing alignment baselines and collecting alignment data is presented in Section 22-5.0. See Figure 23-2B, Alignment Sketch.

23-2.03 Bench Levels

The guidelines and procedures relative to running bench levels and collecting bench level data are discussed in Section 22-5.0.

23-2.04 Data Collector Preparation

The following presents a list of procedures to aid in the preparation of the electronic data collector.

1. select the instrument;
2. select the job settings;
3. configure the reading for collecting data in raw data SDVA format (i.e., slope distance vertical angle);
4. select the input type to accommodate metric units-of-measure; and
5. input data tolerances.

23-2.05 Keyboard Input

The keyboard input that is typically required for the project includes the following:

1. designation number;
2. project number;
3. old or new structure number, as applicable;
4. name of survey firm;
5. names of survey crew personnel;
6. job description and location;
7. coordinates for all centerline and adjusted control points;
8. centerline station, line letter and monument type;
9. start of survey;
10. end of survey; and
11. any additional survey or pick up survey notes, including dates and other description information. Note whether the information is additional survey or pick up survey data.

23-2.06 Setting Temporary Control or Fly Stations

The following presents the procedures for setting temporary control or fly stations.

1. Station Location. Set temporary control stations beyond the roadway in a highly visible location.
2. Survey Control. Set all temporary control stations from the survey control.
3. Third Generation Controls. Third generation temporary control stations are not permitted. If an additional temporary control station is necessary, then return to the survey control line and backsight a control line point. The additional temporary control station may then be set.

23-2.07 INDOT String Label Conventions

For a copy of the current list of INDOT string labels contact the Engineer of Location Surveys at (317) 232-5309 or (317) 232-6764, or download from INDOT's web page at http://www.ai.org/dot/div_design_html.

23-2.08 Topography Plots

The following sections discuss the key information that should be presented on topography plots.

23-2.08(01) Buildings

Identify all building types that extend within the limits of the survey including the following:

1. accurate location;
2. dimensions; and
3. a brief description (e.g., frame, brick, concrete).

Round and record all dimensions to the nearest 30 mm. The extent of coverage from the baseline varies, and the amount of coverage is determined either by the Preliminary Engineering Study Report or the Engineer of Location Surveys. See Figure 23-2C, Topography Plot Example, for an example of presenting buildings on topographic plots.

23-2.08(02) Fences

Identify all fences by at least two points on each tangent of the fence including fence corners. Figure 23-2C presents an example.

23-2.08(03) Trees and Forests

When a wooded tract is encountered, show its limits, and give a general idea of the number and prevailing kinds and sizes of the trees within the survey limits right and left for that particular baseline. Apart from forests, show all individual trees of any appreciable value, particularly trees and shrubs that are located on lawns, etc., and that are within the proposed right-of-way limits. Show all fruit trees large and small. See examples in Figure 23-2C.

23-2.08(04) Fields

The limits of pastures, truck patches, gardens, berry patches, lawns and parks that are within the survey limits should be recorded on the topography plot. Figure 23-2C presents an example.

23-2.08(05) Utilities

All utilities should be identified on the topography plot including the following:

1. electric lines;
2. telephone lines;
3. cable television lines;
4. water lines;
5. gas lines;
6. oil lines;
7. sewer lines (e.g., sanitary, storm);
8. manholes;
9. fire hydrants;
10. transmission line towers;
11. power poles; and
12. underground oil and gas transmission lines.

Power transmission lines must be tied to the baseline by locating either the centerline of high tension towers or all four legs. Both right and left distances from the center of the closest towers must be recorded. The easement width must be obtained from the various utility companies and submitted in the survey envelope. Power, telephone and telegraph poles are observed to the center of the pole. Utility companies prefer that underground utility lines be located and marked by their employees. Further discussion regarding utility companies is presented in Section 22-2.0 of the *Design Manual*. Utilities should then be properly located by the project survey crew and recorded in the topography notes as illustrated in Figure 23-2C, Topography Plot Example.

23-2.08(06) Roadways and Paths

Public roads, private roads and field entrances should be located on the topography plot together with a complete description (e.g., type, purpose or use, width, type of surface, condition). The need to survey S-lines is determined by the Central Office prior to the job assignment. The length and coverage limits required for S-lines is predetermined by the Engineer of Location Surveys. The topography plot also should include the location and description of sidewalks, curbs, gutters, retaining walls and other similar items. Figure 23-2C illustrates examples of locating the items discussed in this section.

23-2.08(07) Railroads

Where railroad switch or mainline tracks are encountered, locate the centerline of track and the gauge side of each rail to the nearest 5 mm. Locate all switch or frog points within the survey limits both right and left of the baseline. It is often determined by the Design Department that surveying a separate line (e.g., RR-1-A) both right and left from the baseline and along the centerline of the tracks is warranted. Such survey lines run from left to right across the baseline using station 5+000.000 at the equation point on the baseline. However, in cases where railroad plans are available, it is permissible to survey railroad lines on railroad stationing. An accurate distance must be obtained that relates to some identifiable feature along each railroad (e.g., RR milepost, RR bridge). Railroad plans might be available at the County Surveyor's Office if unavailable from the Design Division's Utilities Unit.

23-2.08(08) Natural Drainage Features

All natural drainage features should be identified on topography plots. Identify the limits, direction of flow, extreme and ordinary high water elevations and other relevant information for features, such as follows:

1. quarries,
2. gravel pits,
3. streams,
4. lakes,
5. ponds,
6. marshes,
7. springs,
8. sink holes, and
9. dry runs.

Drainage areas 40 ha and less should be determined in the field and recorded in the survey notes. High water elevations are usually recorded in the level notes. An example of presenting natural drainage features is illustrated in Figure 23-2C, Topography Plot Example.

23-2.08(09) Geographical Features

Depict rocks, shale outcrops, peat bogs and muck areas on the topography plot by identifying their area limits. Frequently, rock and muck soundings are taken where required and recorded in the level book. Ditches, tile drains, catch basins and curb inlets must be depicted together with information

describing their location, size, direction of flow, type and depth below surface. Figure 23-2C presents examples of locating the items discussed in this section.

23-2.08(10) Structures

The topography notes should identify all bridges, culverts and small structures. Report in the survey notes, together with corresponding sketches, sufficient details regarding the structure's condition and future usefulness. A bridge is considered a structure that is 6096 mm or longer. Figure 23-2C illustrates an example of the appropriate method to identify structures.

23-2.08(11) Signs

All signs that are within the survey limits (e.g., traffic, public, private) should be presented on the topography plot. Sign dimensions should be determined and recorded to the nearest 30 mm. The sign message should also be noted.

23-2.08(12) Mailboxes

The topography plot should present all mailboxes within the limits of the survey. The size and type of post support and the number of boxes should also be noted.

23-2.08(13) Guardrail

Where guardrail is presented on topography plots, record the X, Y and Z values of the top of the beam rail where it meets the blockout or post. Both horizontal and vertical breaks should be shot. See Figure 23-2D, Guardrail Survey Points.

23-2.08(14) Property Lines

An important objective of a project survey is to collect sufficient data to adequately describe the right-of-way requirements of the project, however, performing a full retracement of every property affected is not an objective of the survey. As such, the following statement shall be recorded on the general information page of all project survey books.

The purpose of this survey is to collect data for the design of a highway improvement, and to provide a basis for describing any right-of-way needed for the project. It is not a property retracement

survey. Any apparent property lines or corners, or subdivision or section corners are based on physical evidence or testimony. For example, a fence between two houses could be noted as an apparent property line.

The survey party should gather all information pertaining to evidence, physical or otherwise, of property lines including the following:

1. fences,
2. iron pipes,
3. rebars,
4. stakes,
5. hedge rows,
6. tree lines,
7. field divides, and
8. testimony.

Where located, record these items in the survey book as, for example, “apparent property line” or “apparent corner” (i.e., App. PL or APP. Cor.). Locating markers should be conducted with a high degree of accuracy. Where a property line exists without evidence or testimony, a statement should be recorded in the topography notes indicating that there is “no evidence of property line” (i.e., NEPL). It is important to not compute the locations of property lines just so they can be plotted for the survey. Only record the physical evidence or testimony. Property owner names should be recorded on both sides of any property lines. When evidence or testimony is unavailable, property deeds may be used to determine the general limits of ownership.

Where a subdivision is involved, it is necessary to locate the subdivision corners within the project limits. At least one additional corner beyond the project limits is required to indicate direction. If subdivision corners are unavailable, then individual lot corners should be identified. The number of corners required is based on a prudent search and should represent a consensus of surveys conducted in the area.

Identical procedures should be followed to locate property corner markers of metes and bounds descriptions. An accurate location of the property corner markers is required for the same reasons as previously noted. A reasonable and prudent search should be made for existing markers within the project limits. If the last deed of record is examined, the monument corners referenced by the instrument should be located and, if not found, it should be noted. Not all property corner monuments need be located, however, property corner monuments should be located for all property lines which intersect the centerline or are within the survey limits. However, the purpose of the survey is not to retrace the entire description in the field.

In all cases, copies of subdivision plats and any metes and bounds descriptions should be transmitted to the office along with the completed survey books.

23-2.08(15) Right-of-Way Lines

Any physical evidence of right-of-way lines should be identified on the topography plot including the following:

1. fences,
2. property corner markers,
3. poles,
4. edge of field, and
5. right-of-way markers.

Physical evidence of property and right-of-way limits should be recorded in the data collector. For right-of-way markers, locate and record the center of the back edge of the marker. All other monuments are to be located at the center of the monument.

23-2.09 Special Procedures for MOSS Users

The following are special procedures that should be considered by MOSS users.

1. 201's (straight);
2. 202's (curve);
3. 203's (parallel line);
4. circles;
5. rectangles;
6. offsets for objects that cannot be seen due to obstructions as follows:
 - a. Angle offsets are made by observing the horizontal angle with one reading and the vertical angle and distance with another. The two are then combined into one observation record.
 - b. Single-distance offsets are made by observing a prism located at a known distance from the target point. The direction from the prism to the target is normal to or along

the line- of-sight from the instrument to the prism. The instrument measures the angle and distance to the prism. The offset distance and the offset direction are input into the data collector.

7. taping;
8. closing;
9. repeat shot;
10. discontinuities;
11. P-notes are notes that are related to a single point and should immediately follow the observation (e.g., P 1234 0.15 CMP outlet); and
12. S-notes are notes that relate to a single string and can be placed after the first or last shot in that string or anywhere in between (e.g., S UT01 200 pair cable owned by Ameritech).

23-2.10 Checking Shots

At least once every half hour, the horizontal circle reading on the backsight should be checked. If a discrepancy of only a few seconds is found, the circle may be reset, and data collection may continue. If a greater discrepancy is found, then the source of error should be located and corrected. At least once during each set-up, a check shot should be taken. If the same set-up is used during the morning and afternoon, a check shot should be taken during each session. A check shot should be conducted on a known point such as centerline control point. This reconciles the horizontal angle, the vertical angle, and the distance between the control points.

23-2.11 Data Processing Checks

The following presents a list of items that should be checked during data processing:

1. string crossings,
2. triangles,
3. contours,
4. corrupt discontinuities,
5. format of notes,
6. validity of codes, and
7. single point strings.

23-2.12 Survey Transmittals

Chapter Twenty-six discusses the procedures for transmitting surveys to the Department.